

**TITLE:** Design and simulations of a Multi-Lofthole MicroSPECT Imager Using Minifying Projections

**BODY:**

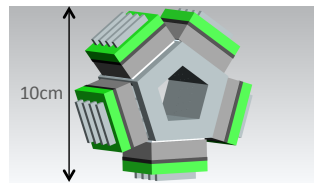
**Objectives :** We are currently building a stationary desktop microSPECT system using minifying projections. The system is based on our previously developed modular scintillation detectors [1] and lofthole collimators [2]. Both system optimization and simulations are discussed.

**Methods :** We modified the formulas from Nillius [3] for a cylindrical instead of a spherical detector arrangement. Furthermore, we also modified the optimization to include loftholes instead of pinholes. Since loftholes have a rectangular projection area, they are more efficient in covering a cylindrical detector surface.

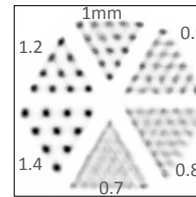
Our optimization considerations resulted in a pentagonal arrangement of 5x5cm<sup>2</sup> detectors, each with 20 pinholes (500µm). The system uses a pinhole distance of 20 mm and a detector distance of 36 mm resulting in a 0.8 magnification factor. The pinholes were arranged in 5 axial rings of 20 pinholes, each looking to a different portion of the field-of-view (FOV) as proposed by Funk [4]. Furthermore, we accurately simulated the complete system, using multi-ray tracing and modelling of pinhole and detector resolution, sensitivity and pinhole edge penetration. We simulated a Derenzo phantom with hot rods ranging from 0.7-1.4 mm. A Defrise phantom in axial and transaxial direction verified sampling completeness. Images are reconstructed with 200 MLEM iterations including full system modelling.

**Results :** In this arrangement, we are able to achieve a point sensitivity of 0.3% in combination with an analytical system spatial resolution of 1.4 mm. The transverse FOV is 3 cm in diameter and 1 cm in axial direction. Using resolution recovery in the reconstruction, we are able to achieve a reconstructed resolution ~900µm in the Derenzo phantom. Visual inspection of the Defrise phantom ensured sampling completeness in axial and transverse direction.

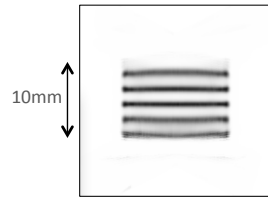
**Conclusions :** These results are encouraging to build the actual system. The low resolution is mainly due to limited detector resolution and is expected to improve in the future.



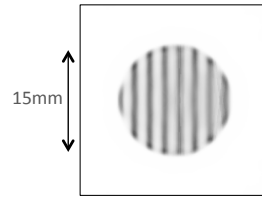
(a)



(b)



(c)



(d)

Figure 1: In (a) the pentagonal system is shown. (b) is a transverse slice through the reconstructed Derenzo (25mm diameter). (c) shows an axial slice through the axial defrise phantom and (d) shows a transverse slice through the transverse defrise phantom